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Extending Service Intervals for Drum-type Meteorological Instruments

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A simple method to extend the service interval of drum-type meteorological recording instruments to 44 days is presented. The chart resolution obtained with a weekly drum rotation is retained after conversion.

Keywords: Meteorological instrument servicing

Meteorological instrument servicing at remote study locations is costly and difficult. Monthly service visits are economically and logistically preferable. However, because of chart trace overlap between rotation periods, it is usually impossible to reduce information from drum-type recorders operated on a weekly rotation cycle when the instruments run for a month. The drive gears can be changed to a monthly rotation cycle, but most information about individual days is then sacrificed because of the compressed time scale.

A need existed to record solar radiation at the Stratton Sagebrush Hydrology Study area with the time resolution provided by a weekly rotation period, but at a monthly service interval. This note describes how two solar radiation recorders were modified to achieve the long service interval without sacrificing the resolution of an 8-day drum rotation. This method is equally applicable to other drum-type meteorological recorders.

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Theory

Two instruments with battery-driven clocks must be used. Roller lever switches, triggered by notches in the chart drum, alternately turn the recorders on and off at 7.33-day intervals. The time offset is necessary to prevent one day's record from being recorded directly over the top of a previous day's record. The normal 8-day drum rotation period was reduced to 7.33 days by changing drive gears. The change in rotation period provided a 16-hour offset between recording periods that facilitated chart interpretation. After 44 days (three rotations of each recorder) the time scale of the first rotation is repeated, and the coincident graphs make chart reduction difficult.

The technique described is ideally suited to meteorological instruments recording cyclic data such as solar radiation, temperature, and humidity. Separation of the chart trace may be more difficult for noncyclic data.

Technical

The pyrheliometer modification required replacing the spring-driven clocks with electric

clocks and changing the gears to a 7.33-day rotation period. The next step in the conversion is to notch the flange on the bottom of the chart drums and install the roller level switches. To accomplish this, first position the drums on the recorders so that the pen tip is centered on the chart clip. Then turn the drums clockwise until the pen tip is 1 cm from the chart clip. Measure 1 cm clockwise from the chart clip (away from the pen) and mark the chart drum flanges. A notch slightly larger than the lever switch roller and two-thirds of the flange width must be cut in each drum at this mark using a small rat-tail file (fig. 1). It is important to keep the notches as narrow as possible, because both clocks will run when both rollers are in the notches simultaneously. This occurs at the end of each revolution of instrument No. 2, but lasts less than 10 minutes if the notches are slightly larger than the rollers.

Switch installation is critical. A subminiature roller lever switch is mounted on each instrument base so that the roller is located 0.5 cm counterclockwise of the notch when the pen is at the beginning of the chart (fig. 1). The roller on the switches must be vertically centered on the drum flange, and some shimming may be necessary to achieve the proper alignment. The roller arms are adjusted to open and close the switches only when actuated by the notches. The switches can be either glued or bolted to the instrument base after proper positioning.

The electrical wiring (fig. 2) was done with No. 22 stranded copper wire, and all connections were soldered. The battery pack was glued inside instrument No. 1 to protect it from the weather. To accomplish the wiring, drill one hole (approximately 0.5 cm in diameter) in the base of instrument No. 1 midway between the battery pack and the chart drum (fig. 3). In addition, also drill a hole in each instrument base 1 cm clockwise from the switch.

The clocks operate on 3 volts, with current supplied by two "D" cell batteries. Battery life will vary according to type of batteries used and operating temperatures. Alkaline cells have a longer life than zinc-carbon cells and should last 6 months even at cold temperatures.

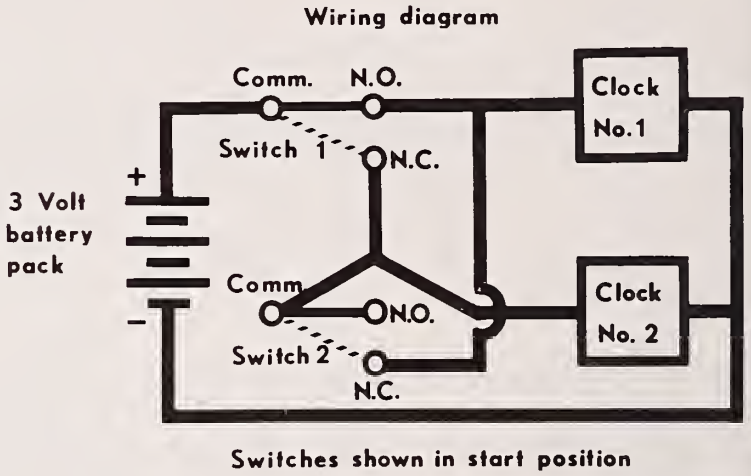

Figure 2.—Wiring diagram to alternately start and stop clock operation at 7.33-day intervals.

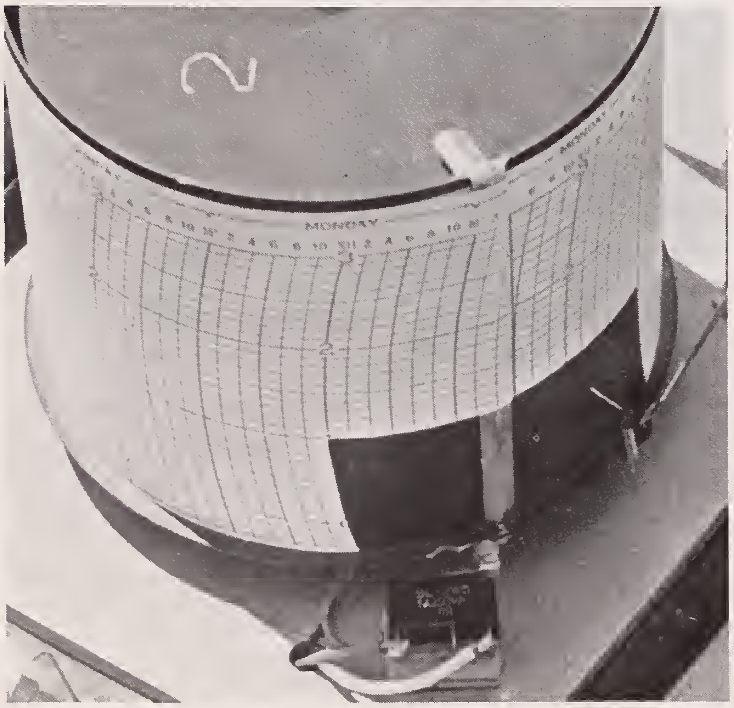

Figure 1.—Chart drums in start position showing position of notches in relation to chart clips.

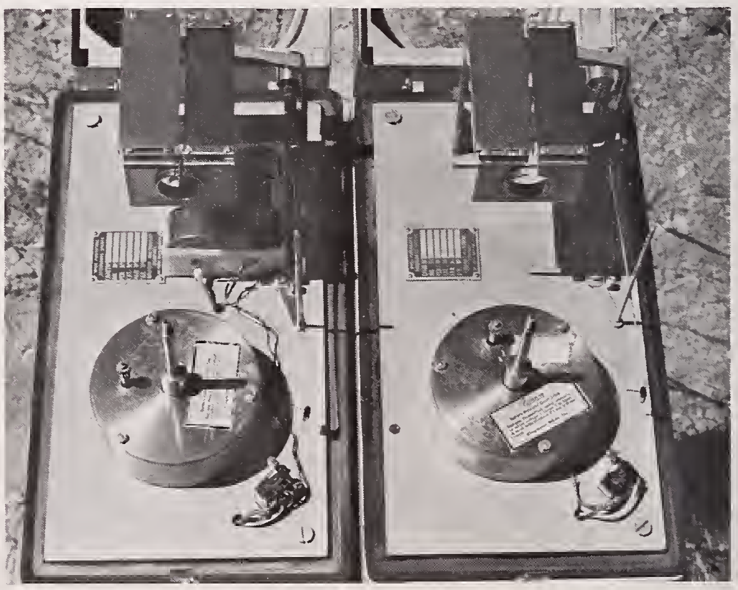

Figure 3.—Pyrheliometers after conversion for extended operation.

Meteorological instrument modification required approximately 3 hours. Exclusive of the two recorders, these items were used to convert the solar radiation recording system:[2]

1. Two electric chart drive clocks, Kingmann-White, model 301 @ $65.00 — $130.00
2. Two, 15 x 110 gear drive sets for clocks, Kingmann-White, @ $7.50 — 15.00
3. Two subminiature roller level switches, Tandy Corp., No. 275-017, @ $1.19 — 2.38
4. Two bucket-type recording pens, Kingmann-White, Model 95, @ $1.50 — 3.00
5. One battery pack, Keystone Electronics, Model Number 176 — .42
6. Two D cell alkaline batteries, @ $.67 — 1.34
7. Miscellaneous wire, solder, epoxy — 1.00

Total $153.14

Chart Interpretation

Figure 4 shows a set of solar radiation charts containing 4 weeks of data. The vertical scale showing the intensity of radiation was not affected by conversion, but premarked time lines on the chart are no longer correct. The drums made one revolution in 7.33 days instead of 8 days, so that actual time intervals were 1.091 times longer than chart time intervals. New daily or hourly time lines must be marked on the chart, if time accuracy is required within a day. When this is a requirement, have charts printed with correct time lines.

A new instrument constant had to be calculated to use in converting the area under the chart trace to daily radiation input, because of the change in time scale. The constant was calculated by multiplying the manufacturer-supplied instrument constant by the ratio of the chart speed change:

$$\frac{7.333}{8} = 0.917;$$

$$0.917 \times \text{Old constant} = \text{Corrected constant}$$

[2]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

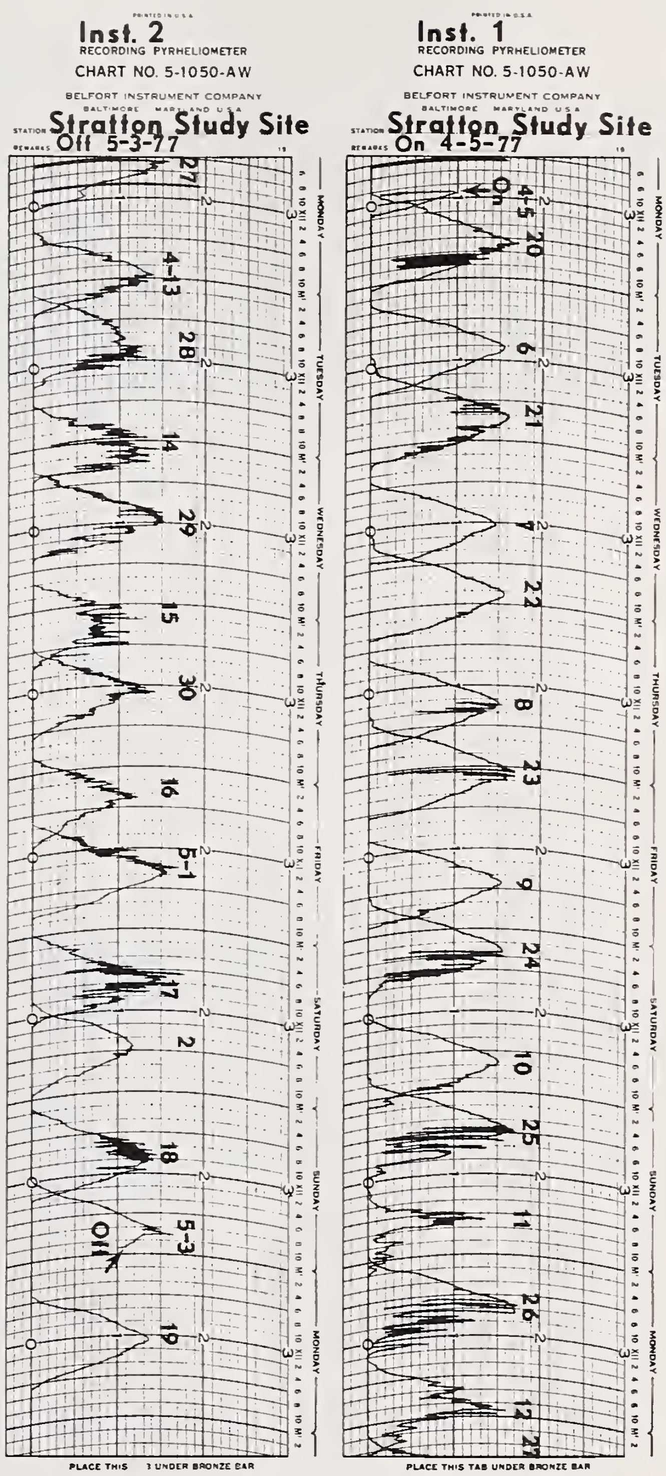

Figure 4.—Two solar radiation charts showing alternate operation over a 4-week period.

The data reduction procedure was not affected by the change in time scale when determining total radiation received each day. A planimeter was used to measure the area under the recorded trace in square centimeters. The daily planimeter reading in square centimeters was multiplied by the corrected instrument constant to determine the solar radiation input in Langleys. Computation of daily radiation totals did not require any adjustment in time lines since the chart trace returned to a constant base level each night.